OCR
Oxford Cambridge and RSA

GCE

Physics A

Unit **H156/02:** Depth in physics

Advanced Subsidiary GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations available in RM Assessor

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error or repeated error
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
___	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

Question			Answer	Marks	Guidance
1	(a)		Sum of thinking distance and the braking distance	B1	**Allow** the (total) distance travelled from when the driver sees a hazard to the vehicle stopping wtte
	(b)	i	$\frac{61000}{3600} = 16.944$ 17 m s^{-1}	M1 A0	**Note** *v* must be the subject
		ii 1	$\frac{1}{2} \times 1.9 \times 10^5 \times 17^2$ $2.7(5) \times 10^7$(J)	C1 A1	**Allow** use of 16.9 gives 2.7×10^7(J)
		ii 2	$0 = 17^2 + 2a \times 310$ OR $\boldsymbol{t = \frac{310}{8.5} = 36.5}$ $a = (-)\frac{17^2}{2\times310} = (-)\frac{289}{620}$ OR $\boldsymbol{a = \frac{17}{36.5}}$ 0.47 (m s^{-2})	C1 C1 A1	**Allow** $v^2 = u^2 + 2as$ with values stated correctly **Ignore** negative sign **Allow** use of 16.9 gives 0.46 **Not** 0.5
		ii 3	$1.9 \times 10^5 \times 0.47$ 89000(N)	C1 A1	**Allow** ECF from **(b) (ii) 1** and **(b) (ii) 2** **Allow** $\frac{2.7\times10^7}{310}$ **Allow** $1.9 \times 10^5 \times 0.46$ **Allow** $\frac{1.9\times10^5\times17}{36.5}$ **Allow** alternatives 87100, 87400, 88000
		(iii)	Component of train's weight acts against the motion/down the incline/same direction as braking force OR some KE transferred to GPE Smaller distance because larger opposing forces/net force or greater deceleration or less work done by braking force	B1 B1	**Not** gravity will slow it down **Not** down, parallel
			Total	11	

Question			Answer	Marks	Guidance
2	(a)		<table><tr><th>*F* / *N*</th><th>***e*** **/ cm**</th></tr><tr><td>0</td><td>**0.0**</td></tr><tr><td>0.49</td><td>**1.0**</td></tr><tr><td>0.98</td><td>**1.8**</td></tr><tr><td>1.47</td><td>2.8</td></tr><tr><td>1.96</td><td>3.6</td></tr><tr><td>2.45</td><td>4.6</td></tr></table>	**B1**	**Note** Column heading required and values in table. **Allow** 0 for 0.0 **Not** 1 for 1.0
	(b)		*y*-axis labelled correctly *e* / cm	**B1**	**Allow** extension / cm or *e* (cm) for *e* / cm
			y-axis scale is simple and uses at least half the graph paper	**B1**	**Note** axis tick labels must be at least every two large squares (4 cm)
			Data points plotted correctly.	**B1**	**Check** two data points (0.98, 1.8) and (2.45, 4.6) Thickness of each point must be less than half a small square
			Straight line of best fit drawn with a straight edge / ruler	**B1**	**Not** freehand / wobbly line
	(c)		Gradient in the range 1.80 to 1.94 OR 0.0180 to 0.0194	**B1**	**Allow** 1.8 or 1.9 OR 0.018 or 0.019 **Not** 2 OR 0.02 **Ignore** POT errors **Ignore** significant figures
	(d)		$k_2 = \frac{1}{\text{gradient}} = \frac{1}{\text{(c)}}$	**C1**	**Note** expect about 0.55 (N cm^{-1}) or 55 (N m^{-1})
			Correct value for k_2 and correct unit N cm^{-1} or N m^{-1} and given to 2 or 3 significant figures	**A1**	**Note** unit must be with correct power of ten

Question			Answer	Marks	Guidance
	(e)		Hooke's law: Extension is (directly) proportional to the load (provided elastic limit not exceeded) Graph is not a straight line passing through the origin so Hooke's law is not obeyed OR Graph is a straight line passing through the origin so Hooke's law is obeyed	B1 B1	
	(f)		k_1= 2 x **(d)** or springs in series = k/n $\frac{2}{3}$	C1 A1	**Allow** $F = k_1e = k_2 2e = k_3 3e$ **Note** 2:3 scores one mark **Allow** 0.66, 0.67
			Total	12	

Question			Answer	Marks	Guidance
3	a	i	Micrometer/(Vernier) calliper Repeat readings (in different directions) and average	B1 B1	**Not** ruler
		ii	$\frac{4}{3}\pi(0.014)^3$ OR 1.15×10^{-5} $m = 650 \times 1.15 \times 10^{-5} = 7.47 \times 10^{-3}$ 0.0075 (kg)	M1 M1 A0	**Allow** $\frac{4}{3}\pi(1.4)^3$ **Note** must see correct POT
		iii	$1000 \times 1.15 \times 10^{-5} \times 9.81 = 0.11$ N OR 0.0075 x 9.81 = 0.074 N *F*= 0.11 – 0.074 = 0.037 (N) OR $9.81\ (1000 - 650)$ or $1.15 \times 10^{-5} \times (1000 - 650)$ *F*= $1.15 \times 10^{-5} \times 9.81\ (1000 - 650) = 0.039$ (N)	C1 A1 C1 A1	**Allow** use of 7.47 x 10^{-3} kg from **a ii** **Allow** ecf from **a ii**

Question			Answer	Marks	Guidance
	b		**Level 3 (5–6 marks)** Clear procedure, measurements **and** analysis *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Some procedure, some measurements and some analysis. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited procedure and limited measurements **or** limited analysis *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**B1** **x6**	**Indicative scientific points may include:** **Procedure** • labelled diagram • long tube • method to determine terminal velocity • check for terminal velocity • safety precaution (tray to avoid spills/ gloves/clamp tube) • method to remove sphere **Measurements** • measurement of diameter • use micrometer/calliper to measure diameter • averages diameter • measurements to determine *v,* e.g. stopwatch, ruler, light gate connected to timer, detailed use of video camera • repeats experiment for same *r* **Analysis** • $r = d / 2$ • determination of terminal velocity • plot a graph of *v* against r^2 • $K =$ gradient.
			Total	**12**	

Question			Answer	Marks	Guidance
4	a	i	$R = \frac{230^2}{3500} = 15.11$ 15 (Ω)	M1 A0	**Allow** calculation of current (15.2) and $R = V / I$ **Not** 3500 / 230 = 15.2
		ii	$A = \pi \times 0.00055^2 (= 9.5 \times 10^{-7}\ \text{m}^2)$ $L = \frac{15 \times 9.5 \times 10^{-7}}{1.6 \times 10^{-6}}$ 8.9 (m)	C1 C1 A1	**Note** 8.9 x 10^n scores two marks **Allow** 15.1 gives 9.0 m
		iii	(Ohm's law states that) V proportional to I (provided the physical conditions/temperature remain constant) Since the temperature is not constant, Ohm's law will not apply	B1 B1	**Allow** one mark for Ohm's law will not apply because as temperature changes the resistance changes
	b		3.5 x 7 or 3.5 x 7 x 7 or 10.5 x 7 or 10.5 x 7 x 7 or 514.5 514.5 x 7.6p = £39.10 or £39.11	C1 A1	**Note** for use of 17 hours £94.96 scores one mark **Allow** 3910p or 3911p or £39.1 or £39.102
	c	i	$V = \frac{1.1}{6.8 + 1.4 + 1.1} \times 6$ 0. 71 (V)	C1 A1	**Allow** $I = \frac{6}{(6.8+1.4+1.1)\times 10^3} = 0.00065$ **Allow** 0.7
	c	ii	As temperature of thermistor increases, resistance of thermistor decreases Total resistance of circuit decreases or current increases Greater proportion of p.d. across fixed resistor or p.d. across fixed resistor increase Reading on the voltmeter will increase	B1 B1 M1 A1	
			Total	14	

Question			Answer	Marks	Guidance
5	a		*phase difference*: difference in degrees/radians/angle between points on the same wave or (similar) points on two waves *coherence*: constant/fixed phase difference	B1 B1	**Note** must be a comparison between points/waves **Allow** how far out of step/sync or leads/lags for difference **Allow** constant / fixed phase relationship **Ignore** 'the frequency / wavelength is the same' **Not** the same phase difference **Not** zero phase difference
	b	i	At point P: path difference between slits and screen is a whole/integer number of <u>wavelengths</u> (for constructive interference) At point Q: path difference between slits and screen is an <u>odd number of half wavelengths</u> (for destructive interference)	B1 B1	**Allow** nλ or λ **Not** phase difference **Allow** $\left(\boldsymbol{n}+\frac{1}{2}\right)\boldsymbol{\lambda}$ **Not** λ/2
		ii 1	x = 4.22 mm $\lambda = \frac{4.22 \times 10^{-3} \times 0.56 \times 10^{-3}}{4.50}$ 5.25 x 10^{-7} m	C1 C1 A1	**Note** x = 42.2 mm or 4.2 x 10^{-2} m scores zero **Note** x = 3.84, 4.77 x 10^{-7} m may score max 2

Question			Answer	Marks	Guidance
		ii 2	$\frac{0.02}{4.5}$ or $\frac{0.02}{0.56}$ or $\frac{0.2}{42.2}$ $\left(\frac{0.02}{4.5}+\frac{0.02}{0.56}+\frac{0.2}{42.2}\right)\times 100 = 4.48\ \%$ Alternative max/min method: $\lambda_{max} = \frac{4.24\times10^{-3}\times0.58\times10^{-3}}{4.48} = 5.49\times10^{-7}$ and/or $\lambda_{min} = \frac{4.20\times10^{-3}\times0.54\times10^{-3}}{4.52} = 5.02\times10^{-7}$ $\frac{\Delta\lambda}{\lambda}\times 100 = 4.4\%\ or\ 4.6\%$	C1 A1 B1 B1	**Allow** 4% or 5% with evidence of working **Ignore** significant figures
	c	i	$\frac{6.63\times10^{-34}\times3\times10^{8}}{5.25\ \text{x}\ 10^{-7}} = \frac{1.989\times10^{-25}}{\mathbf{5\ b\ ii\ 1}} = 3.79\times10^{-19}$ J $n = \frac{50\times10^{-3}}{3.79\times10^{-19}} = 2.5\times10^{23}\times\mathbf{5\ b\ ii\ 1} = 1.3\times10^{17}$	C1 A1	**Allow** ecf from **bii**
		ii	2.6 eV = 2.6 x 1.6 x 10^{-19}= 4.16 x 10^{-19} J ORA Energy of photon is less than work function so photoelectrons will not be emitted	M1 A1	**Allow** photon has 2.37 eV of energy **Allow** conclusion based **5 c i**
			Total	13	

Question			Answer	Marks	Guidance
6	a		A progressive wave transfers energy/information (in the direction of the wave)/all points have (the same) amplitude In a stationary wave there is no net energy transfer/energy is stored/has points which are always zero amplitude/or points have different amplitudes	B1 B1	**Note** for two marks there must be a comparison **Allow** stationary wave has nodes (and antinodes) for one mark
	b		**Level 3 (5–6 marks)** Clear explanation of observations **and** correct method to determine the speed of sound *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear explanation of observations **or** correct method to determine the speed of sound **or** has limited explanation of observations and limited method for the determination of the speed of sound *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Has limited explanation of observations **or** limited evidence of method to determine the speed of sound *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	B1 x6	**Indicative scientific points may include:** **Explanation of Observations** • Understanding of how the standing wave is formed from the interference between the incident and reflected wave • Idea of nodes and antinodes • Node at closed end and antinode at open end • Understanding of the direction of oscillation of particles • Fundamental frequency/1st harmonic indicated for closed tube. • Fundamental frequency/1st harmonic indicated for open tube • Harmonics indicated for closed tube • Harmonics indicated for open tube **Determination of speed of sound** • λ correctly linked to length • $v = f\lambda$ • v calculated for different harmonics/tube or appropriate graphical method • 338 m s^{-1}
			Total	8	

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